

## **Performance of externally bonded reinforced concrete structures using carbon fiber reinforced polymer in tropical climate**

### **Abstract**

Strengthening of existing concrete structures may be necessary in order to overcome the increase in loading capacity and also environmental effect. Durability and ductility are essential to the long-term sustainable service life of FRP material and concrete structural members with FRP reinforcement. Structural reliability and durability implies good performance of material that are able to resist degradation and capable to avoid structural damage. The strengthening of concrete structures through the use of externally bonded FRP composite system raises concern on the durability of the FRP materials at two locations. The first ones is the durability of the FRP material itself and the other one the durability between FRP material and the concrete substrate. The renewal of structural inventory is best summarized into (i) rehabilitation that include the application to repair, strengthening and retrofit structures and (ii) new construction with all FRP or new (Van Den Eijnde et al., 2003).

Tropical climate of countries which experience high average annual temperature, humidity, rainfall and relatively constant ultra violet ray (UV) may have detrimental effect on the usage of FRP composite either externally or internally retrofitted. The rainy season or the most rainfall is experienced by East Malaysia in the October through February with annual rainfall of 5080 mm compared to 2500 mm of annual rainfall for the Peninsular Malaysia. Even though, the temperature is quite consistent throughout the year, the temperature records in Malaysia for the last fifty years has shown a warming trend (Zhao et al., 2005). The amount of information on the durability of FRP subjected to environmental condition especially in the tropical climate environment is still very limited in the literature. Concluded researches show inconsistencies in the results on the degradation effect. It is crucial to study the tropical climate effect of using FRP and its matrix material in structures element in order to gain acceptance in a country which is experiencing tremendous wet and dry cycle through rain, moisture and dry season. This is essential because many of the applications of FRP as strengthening or repair materials are for outdoor environment. However, there is another concern of using FRP as external strengthening materials which is interfacial fracture along the bonded joints that can limit the strengthening performance of FRP materials. It is essential for the long term behavior of the structural bonded

joints in civil engineering structures be guaranteed between 50 to 100 years for the acceptance of this bonded system in the construction industry (Täljsten, 2006).